



Health as an Entry Point to Sustainable Diets: Exploring Dietary Acid Load, Depression, and Commensality

Azadeh Hajipour

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Azadeh Hajipour

Supervisor:	Jonas Bååth, Swedish University of Agricultural Sciences (SLU), Department of People and Society
Assistant supervisor:	Saeid Doaei, Shahid Beheshti University of Medical Sciences, Department of Community Nutrition
Examiner:	Caroline Hägerhäll, Swedish University of Agricultural Sciences (SLU), Department of People and Society Azadeh shahrad, Swedish University of Agricultural Sciences (SLU), Department of Landscape Architecture, Planning and Management.
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Swedish University of Agricultural Sciences

Faculty of Landscape Planning, Horticulture and Crop Production

Department of Landscape Architecture, Planning and Management

Abstract

This cross-sectional exploratory study primarily investigated how health-oriented framing can enhance engagement with sustainability, using dietary acid load (DAL), fiber intake, commensality, and depression. Although the study was based on a relatively small and homogeneous sample, limiting generalizability, several indicative patterns emerged.

Pearson's correlation analysis showed a positive association between DAL (PRAL) and depressive symptoms ($r = 0.70$, $p = 0.008$), which was confirmed by linear regression ($\beta = 0.165$, $p = 0.008$, $R^2 = 0.49$). Fiber intake was negatively associated with depressive symptoms ($r = -0.65$, $p = 0.017$; $\beta = -0.323$, $p = 0.017$, $R^2 = 0.42$) and with DAL ($r = -0.67$, $p = 0.012$; $\beta = -1.41$, $p = 0.012$, $R^2 = 0.45$). Commensality frequency showed a tendency toward fewer depressive symptoms ($r = -0.47$, $p = 0.058$; $\beta = -2.96$, $p = 0.114$, $R^2 = 0.16$), but the association did not reach statistical significance, and no clear link with DAL was observed ($r = -0.18$, $p = 0.56$; $\beta = -1.89$, $p = 0.747$, $R^2 = 0.01$). Qualitative observations further showed that when sustainability was framed through health, particularly mental wellbeing, participants became more attentive and motivated to reflect on their dietary choices. This suggests that connecting sustainability to personal health may be an effective communication strategy.

Taken together, the findings highlight the potential of health-oriented framing as an accessible entry point to sustainability, while also suggesting that dietary acid load may serve as a useful indicator for linking health outcomes with broader aspects of dietary sustainability. Future research with larger and more diverse populations is needed to confirm these associations and further explore the role of health-based communication in promoting sustainable dietary transitions.

Keywords: Dietary acid load, Fiber, Depression, Commensality, Sustainability, Health

Table of contents

List of tables	6
List of figures	7
Abbreviations	8
1. Introduction	9
1.1 Background	9
1.2 Food choice drivers: Sustainability and Health	11
1.3 Sustainable Diets and Mental Health (Focus on Depression)	13
1.4 Dietary Acid Load	13
1.4.1 Dietary Acid Load as a Nutritional and Environmental Marker	14
1.4.2 Dietary Acid Load and Depression	14
1.5 The Social Dimensions of Sustainable Eating	15
2. Aim and research hypotheses	17
2.1 PRAL and depression	17
2.2 Dietary fiber intake and depression	17
2.3 Dietary fiber intake and PRAL	18
2.4 Commensality and Depression	18
2.5 Commensality and PRAL	19
2.6 Framing Dietary Acid Load for Health and Sustainability	19
3. Materials and Methods	20
3.1 Study Design and Setting	20
3.2 Participant group: rationale, benefits and challenges	20
3.2.1 Rationale for the participant group	20
3.2.2 Potential benefits and challenges	21
3.3 Data Collection Tools	21
3.3.1 Depression	21
3.3.2 Sociodemographic Information and Commensality	22
3.3.3 Dietary Intake	22
3.3.4 Potential Renal Acid Load	23
3.3.5 Structured Meetings and Group Discussions	23
3.4 Data collection procedures	24
3.4.1 Quantitative procedures	24
3.4.2 Qualitative procedures	24
3.5 Statistical Analysis	25
3.6 Support from AI Tools	26
3.7 Ethical Considerations	26

4. Results	28
4.1 Quantitative Results	28
4.1.1 General and Sociodemographic	28
4.1.2 Association between PRAL and Depression	30
4.1.3 Association between Dietary Fiber Intake and Depression	30
4.1.4 Association between Dietary Fiber Intake and PRAL	31
4.1.5 Association between Commensality Frequency and Depression (PHQ-9)	32
4.1.6 Association between Commensality and PRAL	33
4.2 Qualitative Results	34
4.2.1 Observations on Engagement with Food Sustainability Framed through PRAL and Health	34
5. Discussion	37
References	42
Appendix 1	49
Appendix 2	50
Appendix 3	51
Appendix 4	52

List of tables

Table 1.General and Sociodemographic Characteristics of Participants.....	29
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List of figures

Figure 1.Five drivers of food consumption.(Image created with ChatGPT/DALL·E from the prompt “Five Russian nesting dolls (Matryoshka) arranged from largest to smallest to illustrate five drivers of food consumption”, 2024)..... 12

Figure 2.Association Between PRAL And Depression 30

Figure 3.Association Between Dietary Fiber Intake And Depression (PHQ-9).....31

Figure 4.Association between dietary fiber intake and PRAL 32

Figure 5.Commensality frequency in relation to depression (PHQ-9) 33

Figure 6.Association between commensality frequency and PRAL 34

Abbreviations

Abbreviation	Description
SDGs	Sustainable Development Goals
DAL	Dietary acidic load
FAO	Food and Agriculture Organization of the United Nations
WHO	World Health Organization
PRAL	Potential Renal Acid Load
PHQ-9	Patient Health Questionnaire-9

1. Introduction

The overall aim of this thesis is to approach more sustainable diets from a health perspective. Sustainable food choices do not necessarily stem from environmental concern alone but can also be driven by more personally meaningful goals, such as improving health (Vermeir et al., 2020). From this goal-directed perspective, health can serve as a bridge that makes sustainable diets more accessible and relevant in everyday life.

1.1 Background

The global food system feeds over 7.5 billion people but contributes significantly to poor health and environmental damage. It produces 20-35% of global greenhouse gas emissions, uses about 40% of ice-free land, causes water and soil pollution from fertilizers, and biodiversity loss (Rogelj et al., 2018). Changing the food system is essential to meet international sustainability goals, such as the Paris Climate Agreement and the Sustainable Development Goals (SDGs) (Springmann et al., 2018).

According to the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) (2019), if current trends in diet and population growth continue, the environmental and health impacts will worsen. Rising incomes and urbanization are increasing the demand for meat, dairy, sugar, and oils, which leads to more diet-related diseases and environmental damage (Popkin, 1994). Animal-based foods, especially beef and lamb, have a much higher environmental footprint than plant-based foods. Additionally, the expected population increase of 2 billion people by 2050 will further strain the environment (FAO and WHO, 2019).

Of course, discussions on sustainability cannot be limited to meat, fruits, and vegetables. Studies have also pointed to other components of the diet, such as sugar. Lang et al. (2017) outline how sugar agriculture consumes large amounts of water and energy, relies heavily on chemical inputs, and contributes to soil degradation, greenhouse gas emissions, and pollution. These findings suggest that items often deemed “just unhealthy,” such as sugary energy drinks, may also represent unsustainable dietary components when their full environmental and social costs are considered.

Similarly, the growing trend of eating at fast-food restaurants is associated with higher diet-related greenhouse gas emissions, partly due to the large portion sizes typically served and the fact that meat-based dishes make up the majority of menu options, with estimates suggesting they comprise around four-fifths of available items (McCrory et al., 2019; Dunn et al., 2021).

Despite growing knowledge and awareness, food preferences and eating habits remain difficult to change as they are deeply embedded in people's lifestyles and socio-cultural contexts. One possible solution is to approach sustainability through more tangible dimensions that can motivate individuals to take action against the challenges of unsustainable diets, such as health. (Vermeir et al., 2020). The concept of "win-win" diets, which are both healthy and sustainable, has gained wide recognition and promotion in recent years. (FAO and WHO, 2019).

Research shows that adopting a low-meat diet globally could reduce diet-related emissions by nearly 50% and cut premature deaths by about 20% (FAO and WHO, 2019). Studies have shown that these healthy dietary patterns, which are rich in vegetables and fruits and include reduced red meat consumption, are positively associated with a lower burden of various diseases, such as cardiovascular disease, diabetes, colorectal cancer and depression (Shi et al., 2023; Mente et al., 2023; Watling et al., 2022; Lai et al., 2014).

Depression ranks among the most common mental health issues affecting populations worldwide (GBD 2021 Diseases and Injuries Collaborators 2024). Globally, the total number of people with depression was estimated to exceed 280 million, equivalent to 5% of the world's population (Institute of Health Metrics and Evaluation, 2023). It is shown that the prevalence of depression is experiencing a continuous rise within populations (Moreno-Agostino et al., 2021). According to Din Psykiska Hälsa, approximately one in five individuals in Sweden report having received a depression diagnosis at some point in their lives (2024). Nevertheless, it has been shown that the effectiveness of conventional treatments for mood disorders reaches only one-third of patients while half of those patients suffer a relapse (Van Zoonen et al., 2014; Burcusa and Iacono, 2007). In light of these challenges, the identification of modifiable risk factors such as diet stands as a necessary step to build targeted interventions and nutritional psychiatry has emerged as a new discipline in neuroscience (Marx et al., 2017).

Importantly, the relationship between diet and mental health is increasingly understood as bidirectional: while dietary patterns and nutrients can influence mood through biological and psychological pathways, depression and emotional distress may also affect food choices, for example by reinforcing unhealthy eating behaviours. This complexity highlights the need to interpret associations with caution and to consider both directions when studying the links between diet and mental wellbeing (Sedgi et al., 2025).

In my view, this growing attention to nutritional psychiatry may serve as a relevant starting point for developing "win-win" diets. Such an approach would not only address a significant health challenge but also incorporate sustainability considerations within its framework. Consequently, I sought to identify a dietary factor that could connect these two domains, and this search led me to the concept of dietary acid load (DAL).

Dietary acid load reflects the balance between acid- and base-forming foods. Animal-based foods such as meat, eggs, and cheese, which are high in phosphorus and protein, contribute to a higher acid load. Conversely, plant-based foods, particularly fruits and vegetables rich in potassium, magnesium, and calcium, promote an alkaline (base) environment (Remer, 2001). Several studies have identified a positive association between higher DAL and depression (Daneshzad et al., 2020; Milajerdi et al., 2020; Mozaffari et al., 2020).

An additional consideration is whether a “win-win” diet that addresses both health (depression) and sustainability (dietary acid load) can be maintained not only at the individual level but also in social contexts. This raises the question of whether individuals who adopt such a diet would continue to adhere to it when eating together with others, thereby extending its relevance beyond personal health to shared practices of commensality

Studies have shown that depression is less common in people who eat with others (Jung et al., 2022). However, it has also been observed that *"in social contexts, people believe that vegetable foods may be inappropriate for social gatherings"* (Michel et al., 2021). This emphasizes the significance of taking into account the social dimensions of food intake. If we want to promote the benefits of sustainable eating, we must also examine its acceptability on an individual and social level as all influence food choices (Gebreyohannes, 2021). Understanding these interactions can help us design more effective healthy diets that promote both well-being and sustainability.

Given these complications, this study takes an interdisciplinary approach, reflecting the true nature of food, which is shaped by multiple factors. I want to look at the bigger picture by considering all aspects of food choices. My goal is to explore how dietary acid load connects health and sustainability while also taking the social aspects of food into account.

1.2 Food choice drivers: Sustainability and Health

Individual food choices are shaped by many factors, from policy and environment to social and personal influences. Since behavior is driven by both conscious and automatic processes, its complexity must be recognized when promoting sustainable healthy diets (Elliott et al., 2024).

Recent research confirms that consumers often prioritize tangible and short-term benefits over more distant and collective concerns, which helps explain the persistent gap between pro-sustainability attitudes and actual purchasing behaviours (Fernqvist et al., 2024).

This pattern is also evident among younger populations. A recent study of Generation Z in Poland showed that taste, price, and health were rated as the most important determinants of food choice, with convenience also playing a significant role. By contrast, external influences such as social media, consumer trends, or

advertising were considered far less relevant. Furthermore, while many young adults expressed some concern for environmental issues, they felt the impact of their eating habits on their own health much more strongly than their impact on the environment (Halicka et al., 2025).

During my participation in the Foodtech Forum 2024, which was part of a course activity, I was introduced to the metaphor of Russian dolls as a way of conceptualizing food choice drivers. The key point of this metaphor is that the dolls are nested inside one another, where the larger, outer dolls represent the more immediate and tangible drivers of food choice, such as taste, price, and health. Moving inward, the smaller dolls illustrate factors that are still important but often perceived as more distant or abstract in everyday decision-making. In this framing, sustainability was placed at the innermost layer.

In my view, health in particular stands out as a powerful entry point. Unlike environmental concerns, which may appear distant or abstract, health is immediate, tangible, and personally meaningful. Framing sustainability through health may therefore serve as an effective way to bridge the attitude–behaviour gap, making sustainable diets more relevant and accessible in everyday life.



Figure 1. Five drivers of food consumption. (Image created with ChatGPT/DALL·E from the prompt “Five Russian nesting dolls (Matryoshka) arranged from largest to smallest to illustrate five drivers of food consumption”, 2024).

1.3 Sustainable Diets and Mental Health (Focus on Depression)

Emerging evidence reveals that the quality of our nutrition has a significant impact on mental health, particularly depression. Diets rich in whole foods, such as fruits, vegetables, whole grains, lean proteins, and healthy fats, are associated with a lower risk of depressive symptoms, whereas diets high in ultra-processed foods, refined sugars, and unhealthy fats have been linked to an increased risk of depression (Lassale et al., 2019).

The idea that what we eat might affect how we feel emotionally is gaining traction, particularly in the emerging discipline of nutritional psychiatry. Recent large-scale research and meta-analyses have found that those who follow healthy eating patterns, such as the Mediterranean diet, have fewer symptoms of sadness and anxiety (Sánchez-Villegas et al., 2011; Molendijk et al., 2018).

These diets are often rich in plant-based meals and low in red or processed meat, sugar, and saturated fat. In addition to observational studies, intervention trials provide support for the function of nutrition in mental health. The SMILES experiment, one of the first randomized controlled trials in this field, indicated that dietary improvements can considerably reduce depressive symptoms in persons with moderate to severe depression (Jacka et al., 2017).

While the specific mechanisms are still being investigated, various hypotheses have been offered. Diet affects gut microbiota, systemic inflammation, oxidative stress, and brain plasticity, all of which are thought to play a role in depression (Marx et al., 2017). Furthermore, environmentally sustainable diets (high in plant-based foods) frequently overlap with those associated with improved mental health outcomes, making this an especially important area for integrated research.

In light of this, sustainable diets may provide a "double benefit" by promoting both environmental health and individual mental well-being. Because of their dual potential, they are an interesting field for future research, particularly given the expanding global burden of depression.

1.4 Dietary Acid Load

DAL of foods can be evaluated using the potential renal acid load (PRAL) index, which quantifies the net acid-forming potential of individual foods or entire diets. Negative PRAL values indicate a shift toward an alkaline or base-forming profile, whereas positive values represent a shift toward a more acid-forming dietary pattern (Rolf and Januszko, 2024). Diet strongly influences acid–base balance. After digestion and absorption, nutrients such as sulfur amino acids generate acid, while organic salts generate alkali. These products are metabolized in the liver and ultimately excreted by the kidneys, meaning the diet determines the body's net acid or base load (Remer, 2001).

PRAL is calculated based on the nutrient content of foods, especially protein, phosphorus (acid-forming), and potassium, calcium, and magnesium (base-forming). Diets that are high in animal-based foods such as red meat and cheese generally result in a higher PRAL score, while plant-based foods which is high in fiber like fruits, vegetables, and legumes typically lead to a negative PRAL value (Remer, 2001).

From a nutritional perspective, PRAL has been widely studied in relation to health outcomes. Research suggests that diets with a high acid load may contribute to increased inflammation, impaired kidney function, reduced bone mineral density, and greater risk of chronic diseases such as hypertension and type 2 diabetes (Fenton et al., 2009; Akter et al., 2014).

From this point onward, the terms DAL and PRAL will be used interchangeably to refer to the same concept.

1.4.1 Dietary Acid Load as a Nutritional and Environmental Marker

While DAL has not traditionally been applied as an environmental measure, the foods that contribute to higher DAL values are largely animal-derived and associated with greater environmental burdens, including higher land and water use and greenhouse gas emissions (Poore and Nemecek, 2018). Conversely, the fruits, vegetables, and legumes that reduce DAL (Remer, 2001) are also among the most environmentally sustainable foods. From my interpretation, the Western dietary pattern, characterised by frequent consumption of fast food and energy drinks, alongside higher intakes of animal protein, fat, and refined grains and lower intakes of fruits, vegetables, and fibre, appears consistent with markers of high dietary acid load. This suggests that such a pattern can be considered acid-forming.

I believe DAL, while already used to reflect the metabolic consequences of diet, can also serve as a tool to frame eating patterns in relation to sustainability. Although it does not directly measure environmental impacts, it reflects dietary patterns that are broadly aligned with sustainability goals. In this study, DAL is therefore used not only to capture the metabolic impacts of diet but also as an indicator of more climate-conscious and sustainable food choices.

1.4.2 Dietary Acid Load and Depression

In recent years, researchers have started to investigate how DAL, a measure of how foods influence the body's acid-base balance, may relate to mental health, especially depression.

Several studies have found a link between higher dietary acid load and increased risk of depressive symptoms. For example, Milajerdi et al. (2020) found that adults with a more acid-producing diet were more likely to experience symptoms of

depression and anxiety. Similarly, in a study conducted by Zare et al. (2025), women with higher DAL scores had significantly greater odds of reporting depression, psychological distress, and sleep problems compared to those with lower DAL diets. These associations remained even after controlling for physical activity and overall energy intake.

The biological mechanisms behind this relationship are not yet fully understood, but several theories exist. One possibility is that a high acid load may lead to low-grade systemic inflammation and increased oxidative stress, both of which are known to contribute to the development of depression (Marx et al., 2017).

While most current studies are observational and cannot prove causation, their findings point toward an important direction for future research. As dietary acid load can be easily estimated from nutrient intake, it may serve as a useful tool in identifying dietary patterns that influence mental health. The overlap between high-DAL diets and low-quality, unsustainable eating patterns also makes this a relevant area.

1.5 The Social Dimensions of Sustainable Eating

Recent studies indicate a growing public interest in sustainable diets, reflecting an increased awareness of the environmental and health impacts of food choices. For instance, research analyzing public interest in food sustainability found a positive association between general sustainability concerns and the adoption of flexitarian diets, which emphasize plant-based foods while allowing for occasional meat consumption (Portugal-Nunes et al., 2023).

Although individual interest in sustainable eating is growing, putting this into practice, especially in social situations, remains difficult. Traditional eating norms at social events often conflict with sustainable food choices. According to Graça et al. (2019), even with increasing awareness, people find it hard to stick to sustainable diets socially, mainly because they want to be accepted and follow group expectations.

In the context of depression treatment, social interactions play a crucial role. Group therapy and socially engaging activities have been shown to alleviate depressive symptoms by fostering a sense of belonging and support among participants. For example, activity-based group therapy has been associated with improvements in mood and self-efficacy among individuals with depression (Ngooi et al., 2022).

Moreover, communal eating has been explored as a therapeutic intervention in mental health care. A study on culinary medicine cooking workshops, which integrated healthy eating with positive food experiences, reported significant improvements in mood among participants, including reductions in sadness and hopelessness, particularly in patients with depression (Mörkl et al., 2024).

Considering all these aspects, it is important to recognize that the social dimension of dietary recommendations and interventions should not be overlooked.

2. Aim and research hypotheses

The overall aim of this thesis is to investigate sustainable diets from a health perspective, using dietary acid load as a central lens, while also considering the social dimension of eating together. Drawing on my background in nutrition and by exploring the concept of dietary acid load, I seek to contribute to the growing field of nutritional psychiatry and to support the promotion of sustainability in ways that benefit both mental health and the environment. The hypotheses are derived from previous research and are formulated as exploratory guiding foci. Although statistical analyses were conducted, the small sample size means that the results should be interpreted with caution and regarded as indicative patterns rather than confirmatory evidence.

2.1 PRAL and depression

Previous study have shown that diets with a higher potential renal acid load (PRAL), typically due to higher consumption of animal protein and processed foods and lower consumption of fruits and vegetables, may contribute to systemic inflammation which is linked to depression (Wu et al., 2019). Review evidence has reported a positive association between PRAL and depressive symptoms (Zare et al., 2025). Based on this background, the first hypothesis is formulated as follows:

H1a (alternative): Higher dietary acid load (PRAL) is positively associated with higher depression scores (PHQ-9).

H1b (null): There is no association between PRAL and PHQ-9. H2 (Commensality and depression)

2.2 Dietary fiber intake and depression

Several lines of evidence indicate that higher dietary fiber intake, reflecting a more plant-based and sustainable dietary pattern, may have protective effects against depression. A recent systematic review and meta-analysis by Saghaian et al. (2023) found an inverse, dose–response association: for every 5 g/day increase in fiber intake, the odds of depression dropped by approximately 5%.

A broader review by Aslam et al. (2024), combining observational studies and RCTs, supported the observational association between fiber and lower depressive symptoms. Additionally, Saghaian et al. (2021) reported higher fiber intake correlated with better mental health outcomes, including reduced distress, anxiety, and depression in women.

In line with this reasoning, and to simplify the discussion of sustainability, fiber was considered a proxy for sustainable dietary patterns and examined in relation to both dietary acid load and depressive symptoms.

Based on this evidence, the second hypothesis is formulated as follows:

H2a (alternative): Higher dietary fiber intake is associated with lower PHQ-9 scores.

H2b (null): Fiber intake is not associated with PHQ-9.

2.3 Dietary fiber intake and PRAL

Several lines of evidence indicate that diets rich in fiber—typically plant-based in nature—are associated with a lower dietary acid load (PRAL). For example, observational and clinical reviews have shown that plant-based diets, which are naturally high in fiber, effectively reduce PRAL compared to typical Western patterns (Storz, Ronco and Hannibal, 2022). Additionally, analyses of NHANES data reveal that individuals consuming low-PRAL diets report significantly higher fiber intake (Storz and Ronco, 2023).

Based on this evidence, the third hypothesis is formulated as follows:

H3a (alternative): Higher dietary fiber intake is associated with lower PRAL.

H3b (null): Fiber intake is not associated with PRAL.

2.4 Commensality and Depression

Commensality, or the practice of eating meals together, has been identified as a potential protective factor against depression. Evidence from Asian cohorts highlights its importance: for instance, Qiu et al. (2024) found that eating alone, and particularly transitions from eating together to eating alone, were associated with higher risks of depressive symptoms. Similarly, in a large Korean cross-sectional study, Son et al. (2020) reported that lower commensality was significantly associated with depression and suicidal ideation. Together, these studies underscore the link between shared meals and better mental health outcomes.

Based on this evidence, the third hypothesis is formulated as follows:

H4a (alternative): Higher commensality frequency (eating with others more often) is associated with lower PHQ-9 scores.

H4b (null): Commensality frequency is not associated with PHQ-9. Exploratory

2.5 Commensality and PRAL

While evidence on commensality has mainly focused on its links to mental health, some studies suggest that eating together also influences dietary quality. Shared meals are often associated with higher consumption of fruits, vegetables, and fiber, and lower intake of unhealthy food (Hammons and Fiese, 2011; Tani et al., 2015). Since fruits and vegetables lower dietary acid load (Storz, Ronco and Hannibal, 2022), it is plausible that greater commensality frequency could be related to lower PRAL.

Based on this rationale, the fifth hypothesis is formulated as follows:

H5a (alternative): Commensality frequency is associated with lower PRAL.

H5b (null): Commensality frequency is not associated with lower PRAL.

2.6 Framing Dietary Acid Load for Health and Sustainability

Research in health communication shows that the way dietary advice is framed can significantly influence people's engagement. For example, gain-framed nutrition messages that highlight benefits tend to increase attention and promote healthier choices compared to neutral messages (Vidal et al., 2019). Moreover, framing dietary choices in terms of either health or environmental benefits may appeal to different audiences; environmentally conscious individuals are more responsive to sustainability frames, while health-oriented individuals resonate more with health-focused frames (Carfora, Morandi and Catellani, 2022). Thus, framing PRAL either as a health-related or as a sustainability-related concept may shape how participants perceive its relevance and their willingness to adopt sustainable food practices.

Based on this rationale, the sixth hypothesis is formulated as follows:

H6a (alternative): Framing dietary acid load (PRAL) as both a nutritional/health-related concept and as a sustainability-related concept increases participants' perceived relevance and engagement with sustainable food practices.

H6b (null): Framing dietary acid load (PRAL) as a nutritional/health-related or sustainability-related concept has no effect on participants' perceived relevance or engagement with sustainable food practices.

3. Materials and Methods

3.1 Study Design and Setting

This cross-sectional exploratory study was conducted in collaboration with the Västerbo Social Care Organization, located in Malmö, Sweden. This organization has been active for nearly 25 years, providing support and care for young people facing diverse challenges. The target group includes adolescents with psychosocial difficulties, early signs of substance use, self-harming behavior, social withdrawal, early criminality, and various mental health concerns.

The organization operates within an extensive chain of care and a multidisciplinary team consisting of psychiatrists, psychologists, therapists, and an occupational therapist. Västerbo offers a broad range of services, including foster care, residential care homes (HVB), supported housing, outpatient care, and its own educational unit, Västerbo Academy.

The study population includes both the personnel working at this organization and the individuals receiving support. All participants were adults aged 18 years or older.

3.2 Participant group: rationale, benefits and challenges

This section outlines the rationale behind the selection of the participant group and discusses the benefits and challenges that this choice entails. By doing so, it aims to clarify how the composition of the study population may influence both the methods applied and the interpretation of the results.

3.2.1 Rationale for the participant group

The choice of participant group was guided both by the thematic focus of this study and by practical constraints. Since the aim of the project was to explore the relationship between diet and depression, it was essential to engage with a population for whom depression is a relevant challenge. At the same time, the limited timeframe of the thesis made a large-scale study unfeasible. Therefore, the decision was made to concentrate on a smaller and more accessible group within an organisational setting where depression is a recognised issue.

Another important rationale was the likelihood of collaboration. To increase the chances of both accessing participants and completing data collection within the limited timeframe, it was necessary to engage with an organisation that could relate to the aims of the study and recognise the relevance of its focus. By addressing a challenge that the organisation itself was already facing, the study created stronger common ground and a clearer motivation for collaboration. This alignment not only facilitated recruitment but also enhanced mutual understanding between the researcher and the organisation.

In addition to young participants, staff members were also included in the study. This decision was not only guided by practical considerations but also by the aim of capturing a more realistic picture of human interactions within a shared environment. By including both groups, the study sought to mirror the relational structures that exist in families and communities, where health behaviours are shaped through interaction rather than in isolation. In this way, the focus was not solely on individual experiences but on the broader social dynamics that influence dietary practices and mental health outcomes. A social determinants perspective reinforces this approach by highlighting that health behaviours are deeply embedded in and shaped by social contexts, organisational structures, and shared environments (e.g., schools, hospitals, or residential care facilities) (Short & Mollborn, 2015).

3.2.2 Potential benefits and challenges

As outlined above, the choice of participant group carried several advantages in relation to feasibility and relevance. The organisational setting facilitated recruitment within the limited timeframe and ensured that the study addressed a challenge of central importance to both the participants and the host organisation. The inclusion of both youths and staff further allowed for a more socially contextualised understanding of dietary practices and mental health.

However, the focus on a setting where depression is already recognised as a challenge means that the results cannot be generalised to the broader population without caution. A more detailed reflection on the limitations of generalisability is presented in the discussion section.

3.3 Data Collection Tools

All questionnaires and food records were provided in Swedish to facilitate comprehension and ensure that participants could respond accurately in their native or most familiar language. This was particularly important for the young adults supported by the organization, for whom clarity and ease of understanding were essential. In contrast, the structured meetings and group discussions were conducted in English, reflecting the researcher's language of communication and allowing for more nuanced explanation of study objectives and sustainability concepts.

3.3.1 Depression

Depressive symptoms were measured using the Patient Health Questionnaire-9 (PHQ-9), one of the most widely applied instruments for screening and monitoring depression in both clinical and community-based settings. The PHQ-9 is directly based on the diagnostic criteria for major depressive disorder in the *DSM-IV* and *DSM-5*, making it both clinically relevant and research-oriented.

The questionnaire consists of nine items, each corresponding to one of the core symptoms of depression (e.g., anhedonia, depressed mood, fatigue, appetite and sleep disturbances, concentration difficulties, psychomotor changes, feelings of guilt or worthlessness, and suicidal ideation). Participants are asked to report how often they experienced each symptom over the past two weeks, using a 4-point Likert scale ranging from 0 = “*not at all*” to 3 = “*nearly every day*”. Total scores therefore range from 0 to 27.

Traditionally, the PHQ-9 is interpreted with five severity cut-offs:

0–4 = minimal depression

5–9 = mild depression

10–14 = moderate depression

15–19 = moderately severe depression

20–27 = severe depression

3.3.2 Sociodemographic Information and Commensality

Sociodemographic characteristics were collected using a structured questionnaire developed for this study. The questionnaire included variables commonly considered relevant in public health and nutrition research, such as age, gender, place of birth, and educational level. Lifestyle factors including alcohol consumption, nicotine use, medication use, and presence of chronic illness were also recorded to provide context for interpreting dietary and mental health outcomes. Collecting these background variables allowed for the description of the study population and for potential adjustment in exploratory analyses.

In consultation with the organization, it was decided not to collect anthropometric data such as height and weight for the young adults receiving support. This decision was made in order to avoid potential discomfort or sensitivity related to body measurements among this group. As a result, anthropometric measurements were excluded from the study design.

In addition, two items were included to assess commensality, defined as the practice of eating meals with others. Participants were asked how frequently they usually ate together with family members, colleagues, or peers, using a Likert-type response scale ranging from “*never*” to “*almost always*.” These measures captured the social dimension of eating, which has been shown in previous studies to influence both dietary quality and psychosocial well-being. Incorporating commensality variables provided the opportunity to explore not only individual dietary behaviors but also the potential role of shared meals in relation to depressive symptoms and dietary acid load.

3.3.3 Dietary Intake

Participants were asked to complete a two-day food record, consisting of one non-consecutive weekday and one weekend day, in order to capture variation in dietary

habits across the week. This design also helped to reduce recall bias, as participants recorded their food intake shortly after consumption. For cases in which young adults were unable or unwilling to complete the record independently, dietary data were collected through interviews conducted with themselves and together with the staff member responsible for their care, providing general information about dietary habits rather than detailed food records.

3.3.4 Potential Renal Acid Load

DAL was estimated using the PRAL method developed by Remer and Manz, one of the most commonly applied formulas in nutritional epidemiology, alongside the Net Endogenous Acid Production score proposed by Frassetto et al. The PRAL approach has been validated in healthy individuals, demonstrating strong correlations with urinary pH and net acid excretion, thereby confirming its relevance as a proxy for the acid–base balance of the diet (Remer & Manz, 1995). By accounting for the intestinal absorption rates of nutrients, the PRAL formula integrates both acid-forming components (protein, phosphorus) and base-forming components (potassium, magnesium, calcium), thus providing a physiologically meaningful estimate of dietary acid load. PRAL was considered particularly suitable for the present study because it does not require anthropometric data such as body weight or height, which could not be systematically collected in this setting.

The PRAL score was calculated as follows:

$$\text{PRAL (mEq/day)} = [0.49 \times \text{Protein (g/day)}] + [0.037 \times \text{Phosphorus (mg/day)}] - [0.021 \times \text{Potassium (mg/day)}] - [0.026 \times \text{Magnesium (mg/day)}] - [0.013 \times \text{Calcium (mg/day)}]$$

Daily intakes of protein, phosphorus, potassium, magnesium, and calcium were derived from the two-day food record (one non-consecutive weekday and one weekend day).

3.3.5 Structured Meetings and Group Discussions

In addition to quantitative data collection, qualitative information was gathered through a series of structured meetings with personnel and young adults at the Västerbo Social Care Organization. A total of seven meetings were conducted, each lasting approximately 30 minutes. Altogether, 37 individuals participated in these sessions, including five young adults living under the organization's support and the remaining participants being staff members.

The primary purpose of these meetings was to introduce the study, clarify its objectives and procedures, and create a transparent process in which participants could raise questions and provide feedback. Staff members were invited to share their views on dietary habits and everyday challenges observed among the young adults, while the young adults themselves were encouraged to describe their own food practices and experiences in relation to meals and commensality.

To support these discussions, the concept of DAL was presented and used as a lens for explaining aspects of food sustainability. This framing was intended to make sustainability more tangible and easier to understand in the context of daily dietary choices. Notes were taken during each session, and recurring themes were documented for later use in contextualizing the quantitative findings.

These meetings thus served a dual function: ensuring participant involvement and comprehension of the study, and complementing the structured questionnaires and dietary records with context-specific qualitative insights.

3.4 Data collection procedures

This section describes how the data collection was carried out in practice, detailing the procedures for both the quantitative questionnaires and the qualitative conversations. The aim is to provide a clear account of the order, context, and manner in which participants engaged with the study.

3.4.1 Quantitative procedures

The quantitative data collection was coordinated with the management of the organisation, who scheduled specific times for me to meet with staff members. During these sessions, I presented the study, explained its purpose and procedures, and introduced the questionnaires. The questionnaires were printed in paper format and distributed after the introductory session. Importantly, the questionnaires were not completed collectively during the meeting. Instead, participants filled them out individually in their own time. The completed forms were returned to me several weeks later, either through two designated staff members who collected them on behalf of the group or by email from three participants.

Each questionnaire was coded to ensure anonymity, and no personal names were collected. My phone number was provided at the end of the consent form so that participants could contact me if they had any questions. In this way, the questionnaires represented a distinct quantitative method, separate from the qualitative conversations.

3.4.2 Qualitative procedures

The qualitative data collection was carried out through sessions arranged in collaboration with the management of the organisation. As described in detail in the section on data collection tools, these sessions served both to introduce the study and to generate qualitative insights. At the beginning of each session, I presented the aim of my research and initiated a discussion by introducing the concept of sustainable diets. This was done to gauge both the participants' awareness and their level of engagement with issues of sustainability. I then introduced the themes of

depression and dietary acid load, in order to evaluate how participants understood sustainability once it was linked to health outcomes.

During the sessions, I took notes on the participants' reactions and reflections. The group sizes varied across sessions: session one (2 participants including management), session two (4), session three (4), session four (4), session five (12), session six (5), and session seven (6). In total, 37 participants took part in the qualitative discussions. At the end of each session, the questionnaires were distributed, with the request that participants return them within one month.

3.5 Statistical Analysis

All statistical analyses were carried out by the author using R (version 4.4.2). The process was supported by an AI-based digital research tool for guidance on coding and statistical procedures. In addition, the results and interpretations were independently reviewed and verified by a colleague with professional training in statistics to ensure accuracy.

Descriptive statistics were used to summarize sociodemographic and behavioral characteristics. Continuous variables (e.g., age, PHQ-9 scores, PRAL values, fiber intake) were reported as means, standard deviations, and ranges, whereas categorical variables (e.g., gender, education, place of birth, nicotine use, alcohol use, medication use) were summarized as frequencies and percentages.

Dietary variables were derived from the two-day food record (one non-consecutive weekday and one weekend day). Nutrient intakes of protein, phosphorus, potassium, magnesium, and calcium were calculated using the Swedish version of the Nutrition Data software, based on the Swedish Food Agency's database. For each participant, nutrient values were averaged across the two recorded days to obtain final intake estimates.

All dietary variables (PRAL and fiber intake) and PHQ-9 scores were treated as continuous variables in the analyses to preserve variability and maximize statistical power.

Given the exploratory nature of the study and the limited sample size, analyses were restricted to bivariate associations. Pearson's correlation coefficients were calculated to assess relationships between: (i) PRAL and depressive symptoms (PHQ-9); (ii) fiber intake and PHQ-9; (iii) fiber intake and PRAL; (iv) commensality frequency and PHQ-9; and (v) commensality frequency and PRAL. Scatterplots with regression lines were generated to illustrate associations. In addition, simple linear regression models were applied to further examine these relationships, providing estimates of effect sizes (β coefficients) and information on model fit (R^2 values).

The reliance on these relatively basic statistical techniques reflects both the small sample size and the homogeneity of the study group, which precluded the use of more complex multivariable models. Importantly, the choice of methods was not

only a statistical necessity but also aligned with the study's focus on a specific organizational context. Since participants were drawn from one social-care organization with relatively similar backgrounds, the analysis aimed to identify tentative patterns rather than produce generalizable estimates. In this sense, the methodological choices were shaped both by sample limitations and by the study's design as an exploratory investigation of a defined group.

Statistical significance was set at $p < 0.05$, while, consistent with the exploratory design, associations with p values between 0.05 and 0.10 were also reported and interpreted as potential trends.

3.6 Support from AI Tools

I used ChatGPT (OpenAI) as a support tool during the writing process, mainly to improve the structure of some sentences and to reflect on the organization of sections so that the text would flow more clearly. I also used it to receive technical guidance on coding and statistical procedures. In both cases, the tool was used for technical and linguistic support; all ideas, interpretations, and final decisions were made by the author.

3.7 Ethical Considerations

Participation in the study was entirely voluntary. All participants received detailed written and verbal information about the study's purpose, procedures, and their rights before providing informed consent. Written informed consent was obtained from all participants prior to data collection. Participants were not asked to provide names or personal identifiers on any of the questionnaires. Each participant was assigned a unique code that was used during data entry and analysis. Participants were informed that they could withdraw from the study at any time without any consequences, and that declining to participate would not affect their relationship with the Västerbo organisation or the services they receive.

Beyond these procedural aspects, additional ethical reflections were necessary due to the sensitivity of the participant group. The questions relating to body shape or weight were deliberately avoided in order to minimise the risk of triggering negative feelings or body image concerns. When discussing food and eating habits, special care was taken not to frame the conversation in ways that could reinforce or stigmatise eating disorders. The interviews were conducted in a friendly and conversational tone to reduce psychological pressure and avoid the impression of a therapeutic session or a formal inspection. This was especially important since the questionnaire also included sensitive questions like drug use, and it was crucial to ensure that participants felt comfortable and safe when answering.

Finally, the dual inclusion of staff members also required ethical attention, as the organisational hierarchy could potentially influence the responses of young participants. To address this, staff and youths were surveyed separately.

4. Results

In preparation for the study, seven half-hour meetings were conducted with 37 staff members of the Västerbo organization. These sessions focused on presenting the study objectives and discussing issues considered relevant by the personnel in relation to the diets of young adults living under the organization's support. The sessions were deliberately structured to first introduce food sustainability in broad terms and then shift the discussion toward health and dietary acid load. This approach was designed to explore how participant engagement and responses varied depending on the framing of the topic. In addition, a separate group session was held with six young adults to gather their perspectives directly.

At the start of data collection, 16 completed questionnaires were obtained from staff members of the organization. Three of these questionnaires had to be excluded due to incomplete information. From the young adult group, four questionnaires were collected, and dietary information was obtained through interviews. Because these interviews provided more general and less detailed information on diet, exact numerical PRAL values could not be calculated. Nevertheless, the reported dietary patterns made it possible to identify approximate PRAL trends.

This study is exploratory in nature, and the results are therefore analyzed using both quantitative methods (e.g., descriptive statistics and correlations) and qualitative approaches (e.g., thematic insights from meetings and interviews).

To summarise, the number of participants across analyses:

- Qualitative analyses: 37 participants in total.
- Quantitative analyses on general and sociodemographic: 17 questionnaires (4 from supported youths and 13 from staff).
- Quantitative analyse on fiber, PRAI, PHQ-9, and commensality: required complete dietary questionnaires. Therefore, only the 13 participants who had provided dietary, psychological, and commensality data were included.

4.1 Quantitative Results

4.1.1 General and Sociodemographic

This study included a total of 17 participants (mean age = 33 years, range 19–51). Overall, 76% of participants were staff members working within the organization, while 24% were young adults living under its support. Most were female (65%) and born in Sweden (71%). None reported chronic illness. Nicotine use was reported by 35%, alcohol use by 59%, and 24% used medication; only one participant reported drug use.

Education was highest at the university/högskola level (41%), with the rest evenly split between other post-secondary (29%) and gymnasium (29%).

Table 1. General and Sociodemographic Characteristics of Participants

Characteristic	Value	Percentage (%)
Total participants	17	100.0
Mean age (years)	33.29	
Age range (years)	19–51	
Gender (female)	11	64.7
Gender (male)	6	35.3
Place of birth (Sweden)	12	70.6
Place of birth (Not Sweden)	5	29.4
Chronic illness (No)	17	100.0
Nicotine use (Yes)	6	35.3
Nicotine use (No)	11	64.7
Drug use (Yes)	1	5.9
Drug use (No)	16	94.1
Medication use (Yes)	4	23.5
Medication use (No)	13	76.5
Alcohol use (Yes)	10	58.8
Alcohol use (No)	7	41.2
Education: University/Högskola	7	41.2
Education: Other post- secondary	5	29.4
Education: Gymnasium	5	29.4
Work in organization	13	76.5
Live under organization support	4	23.5

4.1.2 Association between PRAL and Depression

As shown in Figure 2 (scatterplot with regression line), there seemed to be a positive relationship between dietary acid load (PRAL) and depressive symptoms measured by the PHQ-9. Participants with higher PRAL values often reported higher PHQ-9 scores, pointing to a tendency toward more depressive symptoms.

The mean PRAL value in the sample was 6.5 (SD = 11.2), ranging from -16.8 (more alkaline diets) to 29.4 (more acid-forming diets). PHQ-9 scores ranged from 0 to 14, with a mean of 4.2 (SD = 3.9), which covered minimal to moderate levels of depressive symptoms.

Pearson's correlation analysis suggested a positive correlation between PRAL and PHQ-9 ($r = 0.70$, $p = 0.008$). Although this correlation was statistically significant, it should be interpreted with caution because the study is exploratory and the sample size is small.

Linear regression confirmed this association: PRAL significantly predicted PHQ-9 scores ($\beta = 0.165$, $p = 0.008$), and the model explained 49% of the variance ($R^2 = 0.49$, adjusted $R^2 = 0.44$). Although a few datapoints appeared as potential outliers, sensitivity checks showed that they did not substantially change the model fit.

Taken together, the findings are in line with the alternative hypothesis (H1a), which expected a positive link between dietary acid load and depression. Still, due to the exploratory design and limited data, these results should be seen as preliminary, and the possibility of no association (H1b) cannot be excluded.

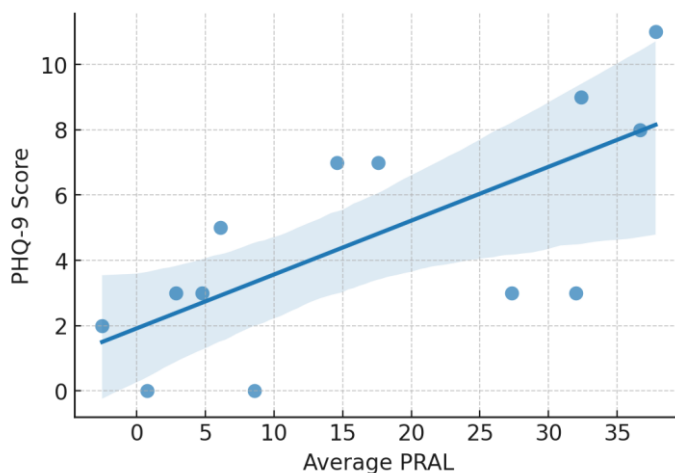


Figure 2. Association Between PRAL And Depression

4.1.3 Association between Dietary Fiber Intake and Depression

As shown in Figure 3, a negative relationship was observed between dietary fiber intake and depressive symptoms. Participants who reported eating more fiber

generally had lower PHQ-9 scores, which may suggest a possible protective role of fiber in relation to mood.

The mean dietary fiber intake in the sample was 23.9 g/day (SD = 7.4), with a range from 13.8 to 35.9 g/day. PHQ-9 scores ranged from 0 to 14, with a mean of 4.7 (SD = 3.5), covering minimal to moderate levels of depressive symptoms.

Pearson's correlation analysis suggested a negative correlation between fiber intake and PHQ-9 ($r = -0.65$, $p = 0.017$). While this correlation reached statistical significance, it should be interpreted with caution given the exploratory design and small sample size. Linear regression confirmed this association: fiber intake significantly predicted PHQ-9 scores ($\beta = -0.323$, $p = 0.017$), and the model explained 42% of the variance ($R^2 = 0.42$, adjusted $R^2 = 0.37$).

Overall, the findings appear consistent with the proposed alternative hypothesis (H2a), which expected that higher fiber intake would be linked to lower depressive symptoms. However, due to the limited data and exploratory nature of the study, these results should be seen as preliminary, and the possibility of no association (H2b) cannot be fully ruled out.

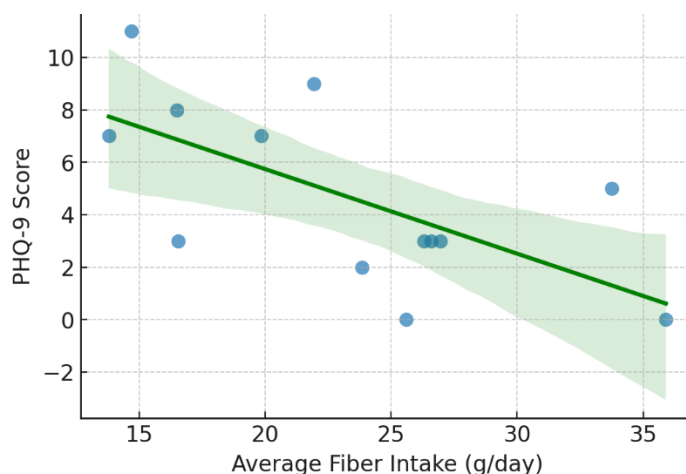


Figure 3. Association Between Dietary Fiber Intake And Depression (PHQ-9)

4.1.4 Association between Dietary Fiber Intake and PRAL

As shown in Figure 4, a negative relationship was observed between dietary fiber intake and dietary acid load (PRAL). Participants who reported higher fiber intake generally had lower PRAL values, suggesting that diets richer in fiber may be more likely to have an alkaline-forming potential.

The average fiber intake in the sample was 23.9 g/day (SD = 7.4), ranging from 13.8 to 35.9 g/day. PRAL values ranged from -16.8 (alkaline-forming diets) to 29.4 (acid-forming diets), with a mean of 6.5 (SD = 11.2).

Pearson's correlation analysis indicated a negative correlation between fiber intake and PRAL ($r = -0.67$, $p = 0.012$). Linear regression confirmed this

association: fiber intake significantly predicted PRAL values ($\beta = -1.41$, $p = 0.012$), and the model explained 45% of the variance ($R^2 = 0.45$, adjusted $R^2 = 0.40$).

While this association reached statistical significance, it should be interpreted with caution given the exploratory nature of the study and the relatively small sample size.

Taken together, the findings are consistent with the proposed alternative hypothesis (H3a), which suggested that higher fiber intake would be associated with lower PRAL values. However, due to the study's limitations, these results should be regarded as preliminary, and the possibility of no association (H3b) cannot be completely excluded.

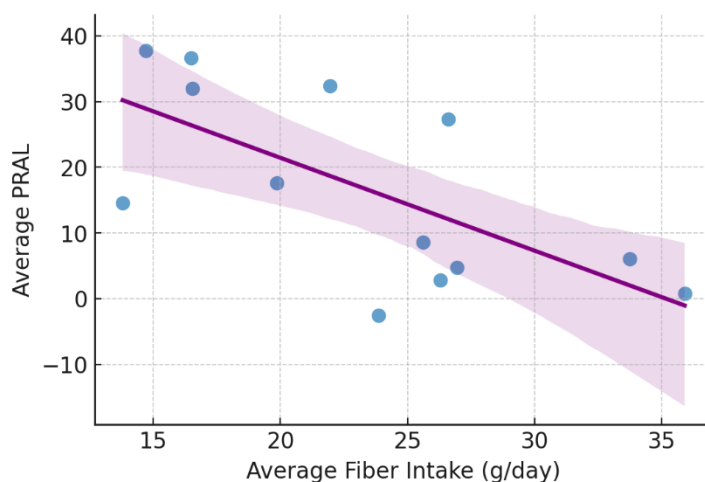


Figure 4. Association between dietary fiber intake and PRAL.

4.1.5 Association between Commensality Frequency and Depression (PHQ-9)

As shown in Figure 5, a negative relationship was observed between commensality frequency (the tendency to eat with others) and depressive symptoms. Participants who ate with others more often generally reported lower PHQ-9 scores, while those who ate alone more frequently tended to have higher scores.

The mean commensality score in the sample was 3.2 ($SD = 1.1$), suggesting that most participants ate with others “often” or “almost always.” PHQ-9 scores in this group ranged from 0 to 14, with a mean of 4.7 ($SD = 3.5$).

Pearson’s correlation analysis suggested a moderate negative correlation between commensality frequency and PHQ-9 ($r = -0.47$, $p = 0.058$). Although this trend points to a possible association between eating with others and fewer depressive symptoms, it did not reach conventional statistical significance at the 0.05 level.

Linear regression showed a similar tendency: higher commensality was associated with lower PHQ-9 scores ($\beta = -2.96$, $p = 0.114$), although the association did not reach statistical significance. The model explained 16% of the variance ($R^2 = 0.16$, adjusted $R^2 = 0.10$).

Overall, the findings are partly in line with the proposed alternative hypothesis (H4a), which expected higher commensality frequency to be linked with lower depression scores. However, given that the result was not statistically significant and the study is exploratory with a small sample size, the possibility of no association (H4b) cannot be excluded.

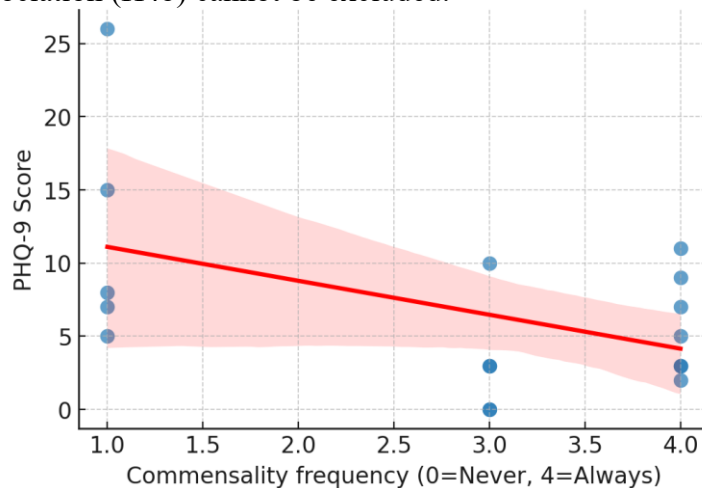


Figure 5. Commensality frequency in relation to depression (PHQ-9)

4.1.6 Association between Commensality and PRAL

As shown in Figure 6, no clear relationship was observed between commensality frequency and PRAL values. Participants who ate with others more often did not consistently show higher or lower PRAL compared to those who ate alone more frequently.

Pearson's correlation analysis supported this impression, showing only a weak negative correlation ($r = -0.18$, $p = 0.56$). The regression line in Figure 6 suggested a slight negative slope, but the result was not statistically significant.

Linear regression similarly indicated no significant association: commensality did not predict PRAL values ($\beta = -1.89$, $p = 0.747$), and the model explained virtually none of the variance ($R^2 = 0.01$, adjusted $R^2 = -0.08$).

Overall, the findings do not indicate an association between commensality frequency and dietary acid load in this sample. While this outcome is not consistent with the proposed alternative hypothesis (H5a), it should be interpreted in light of the exploratory design and the small sample size. Therefore, the possibility of an association cannot be ruled out, but no evidence for such a link was observed here.

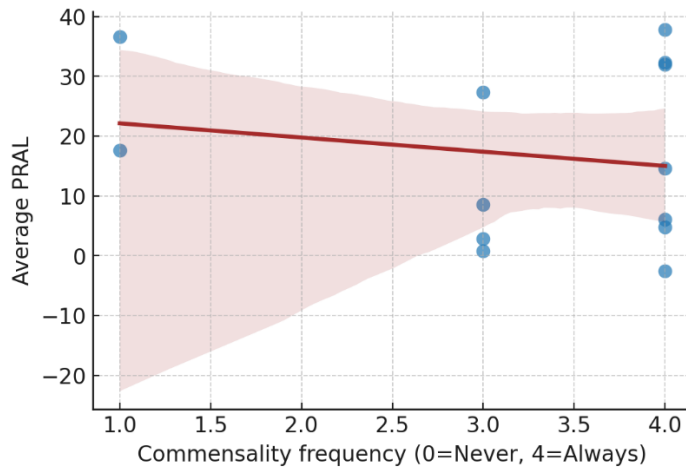


Figure 6. Association between commensality frequency and PRAL

4.2 Qualitative Results

4.2.1 Observations on Engagement with Food Sustainability Framed through PRAL and Health

In addition to the quantitative analyses, qualitative information was collected through structured meetings with organizational staff (seven 30-minute sessions) and a group meeting with six young adults. These observations provide contextual insights into diet and the reception of sustainability concepts.

With respect to dietary habits, staff consistently described adolescents and young adults as showing a strong preference for energy drinks, sugary beverages, and fast-food meals, particularly meat-based products, while exhibiting little interest in fruits and vegetables. As one staff member explained, *“They love energy drinks and fast food — you can find empty cans everywhere along with fast-food packages, while fruits and vegetables remain untouched.”* Another staff added, *“Oh, it’s mostly energy drinks, maybe twenty in a day. Of course there’s no room left for proper food, fruit, or salad, even though these are always available.”*

This perception was confirmed during conversations with young adult participants, who openly reported frequent consumption of fast food and energy drinks, coupled with minimal fruit and vegetable intake. Although fruits and vegetables were always available, participants expressed little motivation to consume them. As one young adult remarked, *“I like soda and energy drinks, they taste good and are just easier to grab!”* Another commented, in Swedish, *“Vem orkar äta frukt?”* (literally: *“Who even has patience to eat fruit?”*). The remark, made in a light-hearted and slightly ironic tone, was immediately followed by laughter and agreement from the others.

When the discussion turned to fast food, chips, and soda, several participants responded enthusiastically, saying things like, *“They’re delicious! What was that word you used... unsustainable?”*

Although detailed records from these interviews were insufficient to calculate precise PRAL values, the reported patterns clearly suggested acid-forming diets with low sustainability and poor nutrient quality.

When food sustainability was introduced in broad terms, such as climate impact or long-term resource use, staff members demonstrated a general understanding and some referred to scientific material they had previously encountered. For example, one participant remarked, *“Yes, I actually read about this, meat production requires a lot of water and land, so it is not very efficient.”* Another added, *“It’s much better if vegetables, fruits, and wholegrain foods are increased in the daily diet, they are much more beneficial for the environment.”*

At the same time, several participants raised different perspectives. They asked about contrasting views they had heard, such as claims that high-meat diets may have therapeutic benefits in certain conditions. As one staff member put it, *“We’ve also heard about high-meat diets being helpful in some illnesses. Jordan Peterson, the psychologist, has even talked about the benefits of eating only meat.”*

What was particularly interesting was that discussions shifted naturally from sustainability toward health, without any direct intervention from the researcher. For example, as seen in the statement above, or in another remark made by one of the participants who said *“I’ve read that a meat-based diet can actually be beneficial,”* while another repeatedly asked, *“But then, how should we cover our daily protein needs?”*

These moments created a natural entry point for the researcher to introduce the health dimension of sustainable diets, particularly the role of PRAL. At this stage, participant engagement clearly increased: individual concerns about personal nutrition overlapped with broader concerns about environmental sustainability. This was reflected in the growing number of follow-up questions.

A similar pattern emerged among adolescents. At the beginning, when I was asked what I was going to do and I briefly introduced myself as a student, explained my field of study, and presented the title of my thesis, they listened with little interest. It was evident that they were waiting for me to finish, and they showed no real engagement with what I said. However, once I moved on to the next part of my explanation, namely, that a diet beneficial for the future of our planet can also promote our own health and improve daily wellbeing, and that this is why I focus on the concept of dietary acid load and depression, the situation changed. At that point, they started listening more attentively and actively. They picked up the questionnaires from the table and began filling them out, while simultaneously engaging in short conversations with me and answering my questions about their everyday food habits.

These qualitative findings indicate that presenting food sustainability through the lens of dietary acid load and its link to health can enhance participant engagement with the topic.

The alternative hypothesis (H6a), stating that framing dietary acid load in relation to health can increase engagement with food sustainability, received preliminary support from these findings. The null hypothesis (H6b), suggesting no effect of framing, cannot be entirely ruled out; however, the observations indicate potential benefits of linking health-related dietary concepts to sustainability communication.

5. Discussion

This cross-sectional exploratory study set out to investigate how sustainability can be understood more deeply when viewed through health. Although conducted with a relatively small sample, the study is among the first of its kind and thus carries value in offering a fresh and challenging perspective on sustainability.

This study suggested several tentative patterns. There appeared to be a positive association between dietary acid load and depressive symptoms, while higher fiber intake seemed to be related to both lower PRAL values and fewer depressive symptoms. Together these tendencies may indicate that more plant-based, fiber-rich diets could contribute to both lower dietary acid load and improved mental wellbeing, although the limited sample size means these results should be viewed as preliminary. With regard to commensality, eating with others more often showed a weak tendency toward fewer depressive symptoms, but no clear link with PRAL was observed. The qualitative observations further indicated that framing dietary acid load seemed to increase participant engagement with sustainability, pointing to health-oriented framing as a potentially useful way to make sustainable diets more personally relevant.

In the following, each of the main findings is discussed in relation to previous literature and contextual factors.

The sample was relatively small and skewed toward female participants, most of whom were born in Sweden. This homogeneity limits generalizability but also reflects the actual demographics of the organization. Importantly, the absence of chronic illness in the group reduces potential confounding from medical conditions, although lifestyle factors such as nicotine and alcohol use were still reported by some participants.

In this exploratory study a positive association was observed between PRAL and depressive symptoms. Participants with higher PRAL values tended to report higher PHQ-9 scores, suggesting that more acid-forming diets may be linked to greater levels of depressive symptoms. Although the correlation reached statistical significance, the small sample size, and the exploratory design mean that these findings should be interpreted with caution and considered preliminary. Evidence from earlier research helps to contextualize this result. Diets that generate a higher renal acid load are often dominated by animal-based and processed foods while providing fewer fruits and vegetables (Remer, 2001). Such patterns have been connected to biological processes like chronic low-grade inflammation (Wu et al., 2019), which in turn is recognized as a risk factor for depression (Kiecolt-Glaser, Derry & Fagundes, 2015). A recent review further highlights that higher PRAL scores tend to coincide with greater depressive symptomatology, strengthening the argument that acid–base balance in the diet may influence mental wellbeing (Zare et al., 2025).

In this exploratory study, higher dietary fiber intake was associated with both lower dietary acid load (PRAL) and fewer depressive symptoms. Participants who consumed more fiber generally had lower PRAL values, suggesting that fiber-rich diets may contribute to a more alkaline-forming dietary profile. At the same time, those with higher fiber intake tended to report lower PHQ-9 scores, indicating a possible protective role of fiber in relation to depression. While both associations reached statistical significance, the small sample size, limited range of depressive symptoms, and the exploratory nature of the study mean that these findings should be interpreted with caution and considered preliminary.

This finding aligns with emerging evidence that dietary fiber may play a protective role in mental health. Large-scale reviews have highlighted that higher fiber intake is generally associated with reduced risk of depression, with dose–response patterns showing that even modest increases in fiber may contribute to lower odds of depressive symptoms (Saghafian et al., 2023). Observational and experimental evidence further supports this link, indicating that fiber-rich diets, often reflective of plant-based and sustainable eating patterns, can contribute to improved mood and reduced psychological distress (Aslam et al., 2024; Saghafian et al., 2021). Possible explanations for this association include the role of fiber in modulating gut microbiota and reducing systemic inflammation, both of which have been implicated in pathways related to depression.

At the same time, it should be acknowledged that the relationship may be bidirectional. For example, depressed individuals with reduced dopamine activity may experience cravings for energy-dense, palatable foods that provide short-term relief, reinforcing emotional eating behaviours. Elevated cortisol levels, resulting from chronic stress and hypothalamic–pituitary–adrenal axis dysregulation, can further increase preferences for high-fat and sugary foods (Avena, Rada & Hoebel, 2009). Collectively, these mechanisms help explain why depression is often associated with higher consumption of processed snacks and sweets, alongside lower intake of nutrient-dense foods such as fruits and vegetables. This highlights the bidirectional nature of the relationship: while diet can influence mental wellbeing, depression itself can also shape dietary choices, often in ways that reinforce unhealthy eating patterns (Sedgi et al., 2025).

This observation is consistent with previous research showing that plant-based dietary patterns, which are naturally high in fiber, are associated with lower dietary acid load compared to Western-style diets (Storz, Ronco and Hannibal, 2022). Analyses of NHANES data also indicate that individuals following low-PRAL diets typically report higher intakes of fiber, further supporting the link between fiber and acid–base balance in the diet (Storz and Ronco, 2023).

Taken together, these patterns suggest a possible pathway in which diets richer in plant-based, fiber-containing foods may simultaneously lower acid load and support mental wellbeing. Beyond the clinical dimension, the findings can be

interpreted as preliminary indications that dietary strategies promoting plant-based foods could align health benefits with sustainability goals by reducing reliance on animal products and resource-intensive food systems. However, given the exploratory nature of the study and its limited sample size, further research in larger and more diverse populations is needed before firmer and more general conclusions can be drawn.

Commensality, defined as the practice of eating together, was also examined in relation to both depressive symptoms and dietary acid load. In this exploratory study a negative relationship was observed between commensality frequency and depression, indicating that participants who ate with others more often tended to report fewer depressive symptoms. However, the association did not reach statistical significance, which means the result should be interpreted with caution. By contrast, no clear association was observed between commensality and PRAL, suggesting that in this small sample eating with others did not consistently translate into more alkaline dietary patterns.

These findings partly resonate with earlier literature. Large-scale studies in Asia have reported that lower commensality is linked to worse mental health outcomes, including higher risks of depression and even suicidal ideation (Son et al., 2020; Qiu et al., 2024). Shared meals are often described as a social buffer that supports psychological wellbeing, and the tendency observed in this study, though not statistically significant, points in the same direction. With regard to diet quality, previous research has shown that eating together is associated with higher intake of fruits, vegetables, and fiber and lower intake of unhealthy foods (Hammons and Fiese, 2011; Tani et al., 2015). Since such dietary choices are known to reduce dietary acid load (Storz, Ronco and Hannibal, 2022), one might expect higher commensality to be associated with lower PRAL. The absence of such an association in the present study is not surprising, since Jönsson, Michaud and Neuman (2021) argue that evidence for commensality's impact on diet quality and health is still inconclusive and highly context-dependent. They also emphasize that the public health potential of commensality remains an open question, and that stronger, more standardized methods of assessing eating together are needed before general recommendations can be made.

The qualitative findings highlight that framing sustainability through the lens of health, dietary acid load and mental wellbeing, significantly enhanced participant engagement. Initially, broad sustainability messaging, such as climate impact or resource use, elicited minimal interest from both staff and adolescents. However, when the conversation shifted to how diet choices impact personal health, particularly mental wellbeing, participant interest visibly increased. Individuals became more attentive, asked questions about protein intake and dietary trade-offs, and engaged actively with questionnaires, a clear sign that linking sustainability with health creates a more accessible and motivating entry point.

This aligns with established principles in health communication. Evidence from larger consumer studies already highlights the importance of considering how messages are framed and aligned with people's existing motivations. Recent research reinforces this perspective, showing that strategies for promoting plant-based eating are more effective when they build on existing orientations rather than oppose them.

A large Portuguese study identified that people approach food with different motivations and orientations. Some orientations make it easier to move toward plant-based and sustainable diets, some are halfway open to change, and some act as barriers to this transition. (Graça et al., 2019). The authors argue that successful promotion of plant-based diets should acknowledge and integrate these diverse orientations. This resonates with the present study's findings: framing dietary acid load through health outcomes provided an accessible entry point that engaged participants who might not otherwise respond to environmental arguments. Together, these insights suggest that linking health and sustainability, while recognizing varied motivations, may be a promising strategy for encouraging dietary shifts toward more sustainable food systems.

Likewise, the concept of the "Planetary Health Diet," proposed by the EAT–Lancet Commission, illustrates how dietary patterns can be presented as beneficial for both human health and environmental sustainability, offering a powerful framing that resonates with diverse audiences (Willett et al., 2019).

This study has several limitations that must be acknowledged. First, the relatively small sample size limited the choice of statistical methods, reduced statistical power, and made it impossible to adjust for potential confounding factors such as age, sex, lifestyle habits, or medication use. This also restricts the extent to which the findings can be generalized, particularly given that participants were recruited from a single organization and the sample was skewed toward women and individuals born in Sweden. Furthermore, the cross-sectional design prevents any causal conclusions from being drawn about the observed associations between PRAL, dietary fiber, commensality, and depressive symptoms.

Another limitation is that diet, commensality, and depressive symptoms were assessed through self-report, which is subject to recall and social desirability bias. Anthropometric data such as height and weight could not be collected, meaning that body mass index and related measures were unavailable as potential covariates. Additionally, due to ethical requirements such as the need for parental consent, it was not possible to include individuals under the age of 18 who were supported by the organization. As a result, the study does not capture the perspectives of younger adolescents.

Finally, the measure of commensality was restricted to a brief frequency indicator, without detail on with whom, where, or what was eaten.

Taken together, these limitations mean that the findings should be interpreted with caution.

In conclusion, this exploratory study offers novelty by introducing health-oriented framing as an accessible entry point to sustainability, making dietary choices more personally relevant and engaging for participants. Using dietary acid load (DAL) as a lens helped to connect diet, depression, and sustainability in a new way, while also highlighting commensality as a potential social factor that may support psychological wellbeing and shape dietary practices.

5.1.1 Implications and Future Research

These results carry relevant public health and policy implications. Promoting fiber-rich, plant-based diets may therefore be valuable not only for their nutritional benefits and potential to reduce depressive symptoms, but also for fostering more sustainable dietary patterns that support planetary health. Positioning health outcomes as a driver for sustainability communication can make global challenges such as climate change and resource use more tangible at the individual level.

Future research should examine these associations in larger and more diverse populations, ideally using longitudinal and interventional designs to clarify causal pathways. Given the bidirectional relationship between diet and mental health, future studies should also investigate how depressive symptoms may influence dietary behaviours as well as how diet may affect mental wellbeing.

Expanding research beyond a single organizational context will be essential for improving generalizability, while deeper examination of social dimensions, such as commensality, could provide a more comprehensive understanding of how diet, health, and sustainability interact in everyday life. Also, further exploration of how DAL functions as a practical indicator connecting diet, health, and sustainability could strengthen both scientific understanding and policy development.

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Appendix 1

Samtyckesblankett för deltagande i studie:

Jag samtycker till att delta i denna studie som är en del av en masteruppsats om sambandet mellan kost och depression. För att möjliggöra eventuell uppföljning och klargörande frågor samlas mitt namn in, men alla uppgifter kommer att behandlas strikt konfidentiellt och endast forskaren kommer att ha tillgång till informationen.

Inga personliga uppgifter kommer att delas med tredje part, och alla resultat kommer att presenteras anonymt i forskningssammanhang. Deltagandet är frivilligt, och jag kan när som helst välja att avbryta min medverkan utan att behöva ange en anledning.

Datum: _____

Underskrift: _____

 Mycket viktigt

Ditt Questionnaire-ID är:

Vänligen skriv denna kod i fältet Q-ID på alla enkäter och på dina dagliga kostregistreringsformulär som du kommer att lämna in till mig.

 Om du har frågor eller vill ha mer information om studien, kan du när som helst kontakta forskaren via följande kontaktuppgifter:

Namn på forskaren: Azadeh Hajipour

E-post: azhr0001@stud.slu.se

Telefonnummer :

Appendix 2

2-dagars kostregistrering, Instruktioner:

- Vänligen fyll i vad du äter och dricker under tre dagar:
- En vardag (*vanliga dagar*)
- En dag under helgen (*lördag eller söndag*)

- Ange detaljerat vad du äter och dricker.
Var så specifik som möjligt och inkludera så många detaljer du kan.
Hur mycket (*t.ex. en hel tallrik, en halv tallrik, en medelstor skål osv.*)
Tillagningsmetod (*kokt, stekt, rå, grillat osv.*)
Mängden olja eller fett du använde i maten (*ange specifikt hur mycket olja du använde, till exempel två matskedar olja*)
För mejeriprodukter, ange fetthalten (*t.ex. komjolk 3% fett, yoghurt 10% fett osv.*)
Om du använder förpackade produkter, skriv ner varumärket och vikten i gram (g) som står på förpackningen (det hjälper mig att hitta detaljer om näringsinnehåll), till exempel en energidryck av märket Red Bull med en volym på 250 ml.

- Vänligen glöm inte att skriva din kod högst upp på sidan och ange vilken veckodag registreringen gäller!

- Om du vill ha hjälp med portionsstorlekar kan du söka på "Portionsguiden Livsmedelsverket" i Google och använda den som referens.

Appendix 3

PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

Q-ID:

Date:

Under de senaste 2 veckorna, hur ofta har du besvärats av något av följande problem?	<i>Inte alls</i>	<i>Flera dagar</i>	<i>Mer än hälften av dagarna</i>	<i>Nästan varje dag</i>
<i>Lite intresse eller glädje i att göra saker</i>				
Känt dig nedstämd, deprimerad eller känt att framtiden ser hopplös ut?				
Problem att somna eller att du vaknat i förtid, eller sovit för mycket?				
Känt dig trött eller energilös?				
Dålig aptit eller att du ätit för mycket?				
Dålig självkänsla – eller att du känt dig misslyckad eller att du svikit dig själv eller din familj?				
Svårigheter att koncentrera dig, till exempel när du läst tidningen eller sett på TV?				
Att du rört dig eller talat så långsamt att andra noterat det? Eller motsatsen – att du varit så nervös eller rastlös att du rört dig mer än vanligt?				
Ankar att det skulle vara bättre om du var död eller att du skulle skada dig på något sätt?				

Om du kryssat för att du haft något av dessa problem, hur stora svårigheter har dessa problem förorsakat dig på arbetet, eller för att ta hand om sysslor hemma, eller i kontakten med andra människor?

- | | |
|--|--|
| ☐ Inga svårigheter | ☐ Vissa svårigheter |
| ☐ Stora svårigheter | ☐ Extrema svårigheter |

Total score:

Appendix 4

Q-ID:

Sociodemographic Questionnaire

Kön	☐ Kvinna ☐ Man ☐ Vill ej uppge
Födelseår (yyyy)	
Vad är din relationsstatus nu?	☐ Jag har en partner ☐ Jag har ingen partner ☐ Osäker / Vill ej svara
Var är du född?	☐ Sverige ☐ Utanför Sverige
Har du någon kronisk sjukdom? (Diabetes, Högt blodtryck, Blodfettrubbning, ...)	☐ Ja ☐ Nej
Använder du någon form av nikotinprodukter eller tobak?	☐ Ja (tex. Cigaretter/Snus/Annat) ☐ Nej
Använder du någon form av droger?	☐ Ja (t.ex: Cannabis/Annat) ☐ Nej
Använder du läkemedel för psykisk hälsa?	☐ Ja (tex. Antidepressiva/lugnande medel/Annat) ☐ Nej
Använder du alkohol?	☐ Ja ☐ Nej
Högsta avslutade utbildningsnivå:	☐ Grundskola ☐ Gymnasium ☐ Högskola/Universitet ☐ Annan eftergymnasial utbildning (tex. Yrkeshögskola/Folkhögskola/Annat)
Bor eller arbetar du på Västerbo?	☐ Jag bor i Västerbo (under deras stöd) ☐ Jag arbetar i Västerbo
Hur ofta äter du kvällsmat/middag <u>med andra under veckan?</u>	☐ Aldrig ☐ Sällan ☐ Ofta ☐ Alltid eller Nästan alltid ☐ Jag äter sällan eller aldrig kvällsmat/middag.

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